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Toxicity of Decamethrin on haematology profile of climbing perch Anabas testudineus (Bloch.)

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ABSTRACT

The present investigation was undertaken to study the chronic toxic effects of a sublethal concentration (0.08 ppm) of decamethrin on the haematological profile of Anabas testudineus over an exposure period of 20 days. The treated fish exhibited several behavioural responses, including loss of natural coloration, turning almost reddish in colour, loss of equilibrium, and jerky movements before death.

The treated group also showed significant alterations in the haematological profile, with decreases observed in haemoglobin (Hb), red blood cell (RBC), and white blood cell (WBC) counts. In contrast, differential leukocyte count (DLC) parameters such as neutrophils, monocytes, and esinophils showed increased values.

These findings indicate that decamethrin exerts adverse chronic toxic effects on fish health. Therefore, it is suggested that maintaining decamethrin concentration below 0.08 mg/L in water is more suitable for the culture of Anabas testudineus to ensure optimum growth performance and survival rate compared to higher concentrations.

Keywords: Anabas testudineus, decamethrin, insecticide, haematology profile, pyrethroid.

INTRODUCTION

The environment is increasingly contaminated with different kinds of pollutants. Pesticides are among the major anthropogenic pollutants that play an important role in controlling various pests responsible for crop damage and in improving agricultural production. Insecticides, fungicides, and herbicides constitute major sources of potential environmental hazards, affecting not only birds, fish, and other animals but also humans when they enter the food chain (Khan et al., 2012).

The indiscriminate use of pesticides in agricultural fields causes serious environmental hazards, particularly affecting aquatic fauna. Unfortunately, most pesticides are non-biodegradable and tend to persist in the environment for long periods. Sublethal concentrations of these chemicals may cause ecological imbalance in aquatic organisms after prolonged exposure, probably due to the cumulative impact of impaired metabolic functions (Abedi et al., 2013).

Anabas testudineus, locally known as “Kawai,” is a freshwater edible fish commonly found in paddy fields, ditches, swamps, and other stagnant water bodies. It possesses a suprabranchial accessory respiratory organ that enables it to survive for extended periods outside water. Fish are highly sensitive to pesticides, heavy metals, and other environmental pollutants; therefore, they are widely used as bioindicators for assessing the impact of pollutants on aquatic ecosystems. Haematological studies in fishes have gained greater significance due to the increasing emphasis on pisciculture and the growing concern regarding pollution of natural freshwater resources in tropical regions. Such studies are considered effective and sensitive indicators for monitoring physiological and pathological changes in fishes (Summarwar and Verma, 2012).

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

Hence, the present study was undertaken to investigate the alterations in the haematological profile and behavioural responses of the air-breathing climbing perch, Anabas testudineus, induced by exposure to decamethrin.

MATERIALS AND METHODS

Anabas testudineus, with an average body weight of 30–35 g, were procured from the local fish market and transported to the laboratory in open containers. To protect them from external infections, the fishes were bathed in 0.1% potassium permanganate solution. Thereafter, the fish were acclimatized to laboratory conditions for 15 days. During the acclimatization period, they were fed artificial floating pellet feed manufactured by Growel Feeds Pvt. Ltd., containing 32% crude protein. The daily ration was provided once a day at the rate of 3% of the body weight.

To determine the acute LC_{50} values of decamethrin for 24, 48, 72, and 96 hours, the method described by the American Public Health Association (2005) was followed. The LC_{50} values obtained for these exposure periods were 3.05 mg/L, 2.25 mg/L, 1.50 mg/L, and 0.80 mg/L, respectively. The sublethal concentration was determined following the method of Hart et al. (1945). Based on the calculation method of Finney (1978), a sublethal concentration of 0.08 ppm was selected for the experiment.

Ten acclimatized fish were exposed to the sublethal concentration (0.08 ppm) of decamethrin, while another group of ten fish was simultaneously maintained as the control under identical laboratory conditions for 20 days. At the end of the exposure period, on the 20th day, the fish were anaesthetized with 1:4000 MS-222 (tricaine methanesulfonate) for two minutes. Blood samples were then collected from the caudal region of the experimental fish. Haematological parameters including haemoglobin (Hb), red blood cell (RBC) count, white blood cell (WBC) count, lymphocytes, neutrophils, monocytes, basophils, eosinophils, and packed cell volume (PCV) were estimated following the methods described by Akela et al. (1996) and Shrivastav (1979).

RESULT

Behavioural Response

The control fish remained at the bottom of the aquarium and exhibited normal behaviour with minimal disturbance. Mortalities, if any, were removed immediately, and behavioural abnormalities were assessed at regular intervals using a modified behavioural protocol checklist described by Klesius et al. (2000). Behavioural scores were assigned daily to individual fish based on the following criteria: 0 = no observable behavioural changes; 1 = abnormal swimming, lethargy or unresponsiveness, and changes in skin coloration; 2 = hyperactivity or excitability with rapid opercular movement; and 3 = death. Mean behavioural scores were calculated for each replicate treatment.

Immediately after introduction into the test solution, the experimental fish showed increased swimming activity, frequent surfacing, and hyperactivity. After 24 hours of exposure, restlessness, rapid surfacing, peeling of skin, and fading of body colour became prominent. Following 48 hours of exposure, the fishes exhibited slightly reduced activity with gradual intensification of colour fading. Gill adhesion and the formation of a thin mucus layer on the gills, operculum, and body surface were also observed at this stage.

After 72 hours of exposure, increased surfacing and frequent air gulping were noticed. The fishes also showed loss of balance and jerky swimming movements. School formation, a characteristic behaviour of Anabas testudineus, was considerably weakened in treated fish compared to the control group. After 96 hours of exposure, ulceration on the trunk and at the base of the caudal and pectoral fins was observed in approximately 95% of the treated fish. A thick mucus layer covering the entire body and gills was present in almost all exposed fish. The treated fish lost their natural coloration and became almost reddish in appearance. Loss of equilibrium prior to death was a common symptom observed in all test fishes.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

Haematological Studies

Table 1 clearly shows that the haemoglobin (Hb) level in the control group was 12.56 ± 0.06 g/dL, which significantly decreased to 6.79 ± 0.11 g/dL in the decamethrin-treated group, showing a highly significant difference ($P < 0.001$). Similarly, the red blood cell (RBC) count decreased from 6.39 ± 0.01 in the control group to 4.58 ± 0.08 in the treated group, which was also highly significant ($P < 0.001$) (Table 1, Figure 1).

The values of neutrophils, monocytes, and eosinophils increased significantly in the treated group, recording 16.1 ± 0.04, 8.0 ± 0.03, and 1.4 ± 0.02, respectively, as compared to the control values of 7.84 ± 2.01, 5.0 ± 0.05, and 1.1 ± 0.03. Among these, neutrophils showed highly significant variation ($P < 0.001$), while eosinophils showed significant variation ($P < 0.01$).

In contrast, lymphocyte and basophil counts showed reductions in the treated group. The lymphocyte count decreased from 68.33 ± 2.42 in the control group to 45.0 ± 0.02 in the treated group, showing significant variation ($P < 0.01$). Basophils showed only minor variation and were statistically non-significant.

Similarly, packed cell volume (PCV) decreased markedly in the treated group (12.01 ± 0.03) compared to the control group (35.97 ± 0.06), indicating significant variation ($P < 0.01$) (Table 1, Figure 2).

At the haematological level, exposure to decamethrin caused marked alterations in several blood parameters. The levels of Hb, RBC, WBC, lymphocytes, and PCV decreased, whereas neutrophils, monocytes, and eosinophils increased. These alterations were either significant, highly significant, or non-significant depending on the parameter studied. Such haematological disturbances may lead to pathological conditions such as anaemia, leukocytopenia, neutropenia, lymphopenia, eosinophilia, and impaired erythropoiesis, indicating severe physiological stress in Anabas testudineus exposed to decamethrin.

TABLE-1 Showing the effects of Decamethrin on Hb, RBC, WBC, DLC, PCV of Anabas testudineus.

Values are mean ± SE of 5 individual observations:-

Variable		**Decamethrin (20 days) exposure**
Parameter	**Control**	**0.08 mg/l**
Blood Hb (gm/l)	12.56 ±0.06	6.79±0.12 ***
TEC(RBC) (x 10^6µl)	6.39±0.01	4.58±0.08 ***
DLC (WBC) (% values)	3.9%	2.7% ***
Neutrophils (x 10^3µl)	7.84±2.04	16.1±0.04 ***
Lymphocytes (x 10^3µl)	68.33±2.42	45.0±0.02 **
Monocytes (x 10^3µl)	5.0±0.03	8.0±0.03 *
Eosinophil (x 10^3µl)	2.0±0.03	3.0±0.02 **
Basophil (x 10^3µl)	1.1 ±0.02	1.3 ±0.02 *
PC (%values)	35.97±0.06	12.01±0.03 **

* P<0.5 Non Significant

** P<0.01 Significant

*** P<0.001 Highly Significant

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Figure-1 Showing the effect of decamethrin on Hb, RBC, WBC in Anabas testudineus (20 days) ***P < 0.001.

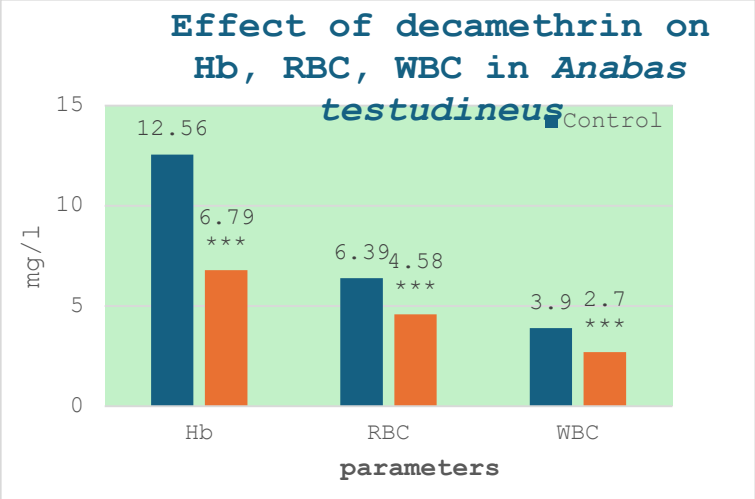


Figure-2 Showing the effect of decamethrin on Neutrophil, Monocyte, Basophil in Anabas testudineus (20 days) *P<0.05, *** P<0.001.

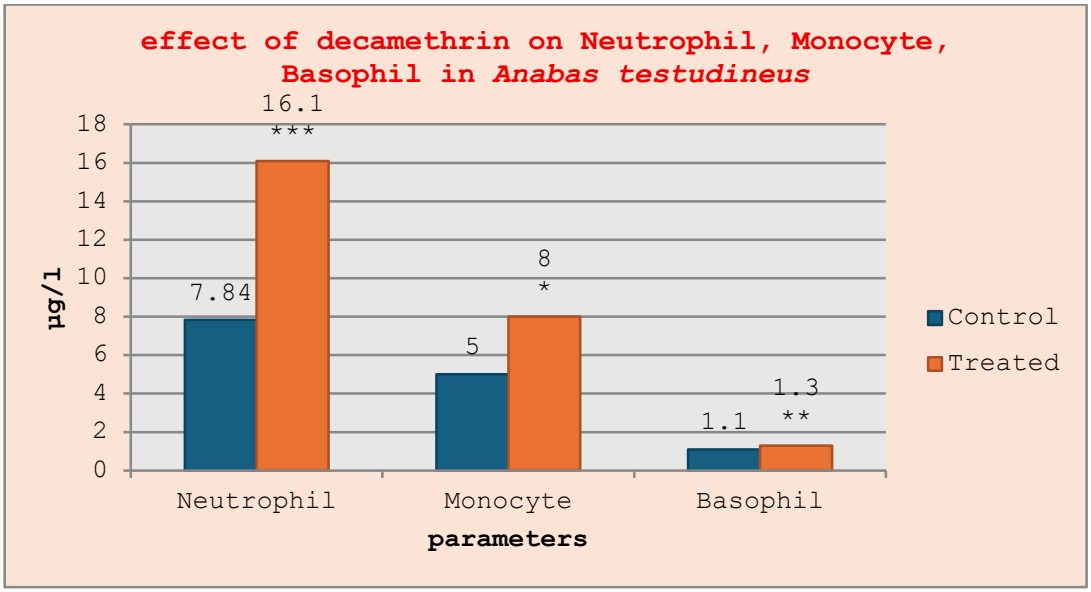
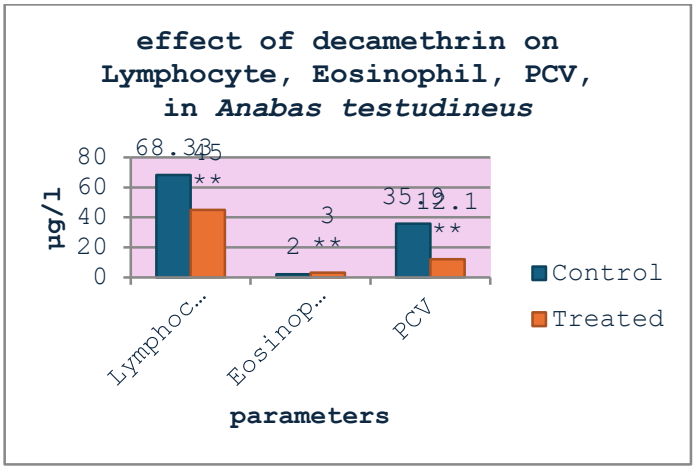


Figure-3 Showing the effect of decamethrin on Lymphocyte, Eosinophil, PCV, in Anabas testudineus (20 days) ** P<0.01.



ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

DISCUSSION

In the present study, certain deformities and abnormal swimming patterns were observed in Anabas testudineus exposed to decamethrin. The experimental fish exhibited recovery when transferred to freshwater, suggesting that the toxic effects of decamethrin may be reversible under sublethal exposure conditions. This indicates that decamethrin possesses considerable toxic potential in shallow aquatic environments and should therefore be used cautiously in agricultural areas located near water bodies. The behavioural responses observed in the present investigation are in close agreement with those reported by earlier workers under various stress conditions (Paul and Banerjee, 1996; Rani et al., 1997; Palanivelu et al., 2005; Ufodike and Onusiriuka, 2008; Lata et al., 2008).

Behavioural responses are considered among the most sensitive indicators of toxic stress in fishes (EIFAC, 1983). Similar acute toxic effects have been reported in zebrafish exposed to mercuric chloride (Vutukuru and Basani, 2013). Likewise, toxic effects of the surfactant dodecyl dimethyl benzyl ammonium chloride on zebrafish larval locomotor activity were observed by Yanan et al. (2015). Thus, it may be concluded that the toxicity of decamethrin depends upon several physical, chemical, and biological factors, each of which may influence its toxic action in fish.

Haematological Study

Haemoglobin (Hb)

The decrease in haemoglobin level observed in the present study is in conformity with earlier findings. Raizada and Gupta (1982) reported a decline in RBC count and haemoglobin content in Trichogaster fasciatus following exposure to the fungicide RH-216. In Clarias batrachus, haemoglobin content decreased significantly after 96 hours of exposure to Rogor. Similar reductions in haemoglobin level have also been reported by Muthalagi (2006) in Cirrhinus mrigala under sewage exposure, by Arjun et al. (2009) under chromium exposure, and by Pratibha and Kumar (2013) under mercury chloride exposure. Comparable decreases have also been reported in mammalian studies by Revathi et al. (2003), Shipra et al. (2005), and Anwar and Choudhary (2009).

Red Blood Cell (RBC)

The reduction in RBC count observed in the present study is in agreement with the findings of Mishra and Srivastava (1983), who reported a significant decrease in RBC count in Heteropneustes fossilis exposed to malathion. Similar declines in RBC levels have been reported by Muthalagi (2006) in sewage-treated Cirrhinus mrigala, Arjun et al. (2009) in chromium-exposed Clarias batrachus, and Pratibha and Kumar (2013) in mercury chloride-treated Heteropneustes fossilis.

The decrease in RBC count may be attributed to disruption of erythropoietic activity and inhibition of glycolysis, resulting in impaired synthesis of blood cells. Toxicants may also directly damage erythrocytes, causing haemolysis and leading to significant reduction in RBC count and haemoglobin concentration.

White Blood Cell (WBC)

The decrease in WBC count observed in the present investigation is consistent with earlier reports on fish and mammals exposed to toxicants such as fertilizers, pesticides, alkaloids, and heavy metals. Similar decreases in WBC count have been reported by Muthalagi (2006) in sewage-exposed Cirrhinus mrigala and by Arjun (2010) in chromium-exposed Clarias batrachus.

A reduction in WBC count, termed leucopenia, indicates suppression of the immune defence system. This may result from toxic damage to blood-forming tissues or excessive utilization of leukocytes during physiological stress.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

Differential Leukocyte Count (DLC)

The present study revealed increased neutrophil, monocyte, and eosinophil counts, while lymphocyte and basophil counts decreased in the treated group. These findings are in close conformity with the observations of Muthalagi (2006), Arjun (2010), and Pratibha and Kumar (2012) under exposure to sewage, chromium, and mercury chloride.

The increase in neutrophils and monocytes may indicate activation of defence mechanisms against toxic stress, whereas lymphopenia may be associated with increased secretion of stress hormones such as adrenaline and corticosteroids. Similar observations have been reported in both fish and mammalian toxicological studies.

Packed Cell Volume (PCV)

The significant decrease in packed cell volume (PCV) observed in the present study is in agreement with earlier reports by Muthalagi (2006), Arjun (2010), and Pratibha and Kumar (2013) under exposure to sewage, chromium, and cadmium chloride. Revathi et al. (2003) also reported a decrease in PCV, mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) with increasing concentrations of tannery effluents.

The decline in PCV reflects anaemic conditions and reduced oxygen-carrying capacity of blood, indicating severe physiological stress induced by decamethrin exposure.

Overall, the present study clearly demonstrates that exposure to decamethrin causes significant behavioural and haematological alterations in Anabas testudineus, indicating its toxic impact on fish health and survival.

CONCLUSION

It could be concluded that Anabas testudineus with average weight 30.0± 4.0 g, were more suitable to culture at water decamethrin insecticide concentration of < 0.8 mg/l for optimum growth performance and survival rate than other water conditions. Therefore, it can be recommended to be carried out under the similar experimental conditions.

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